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Satellite-based analysis of Carbon Monoxide and Fires in the Arctic

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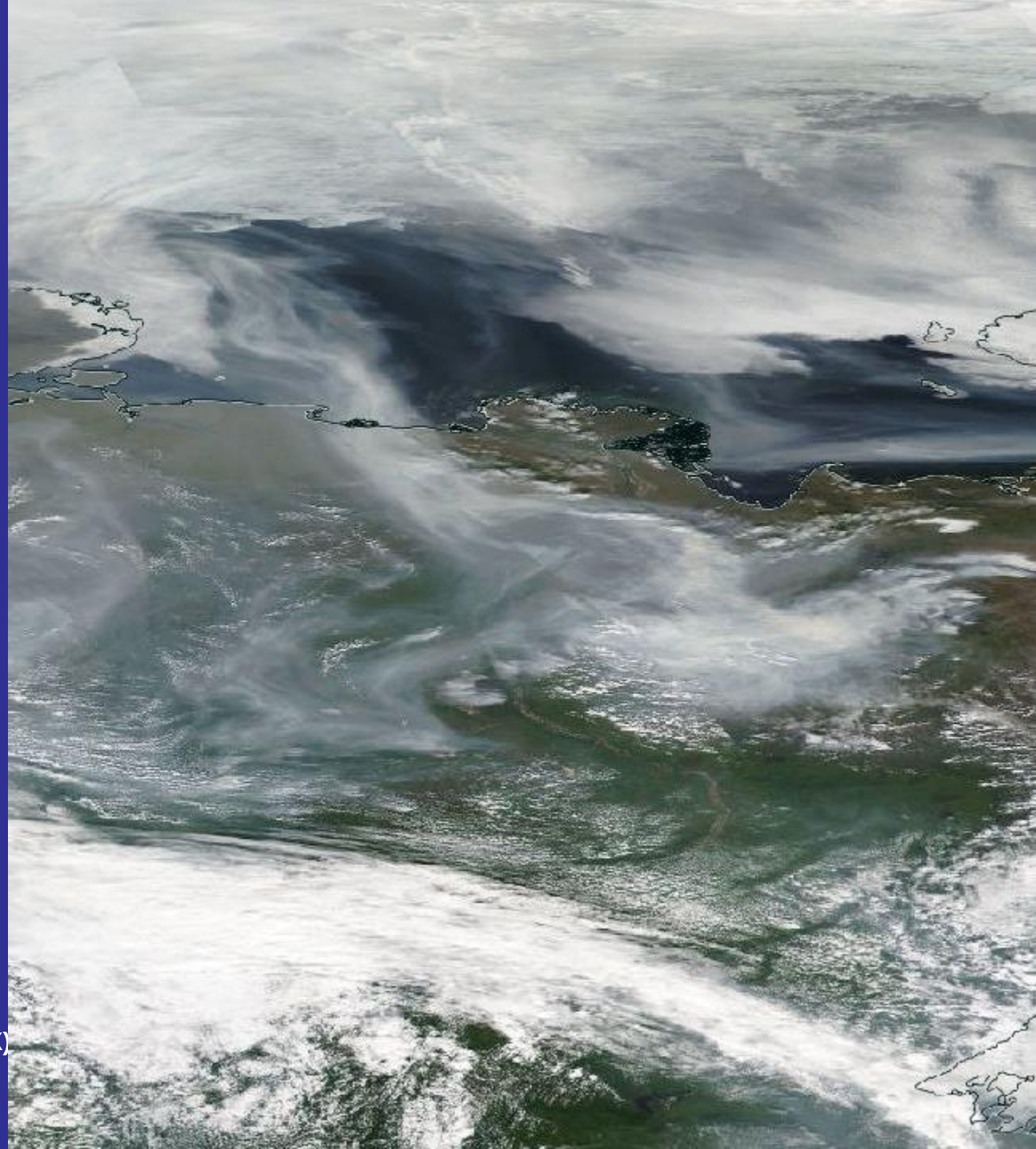
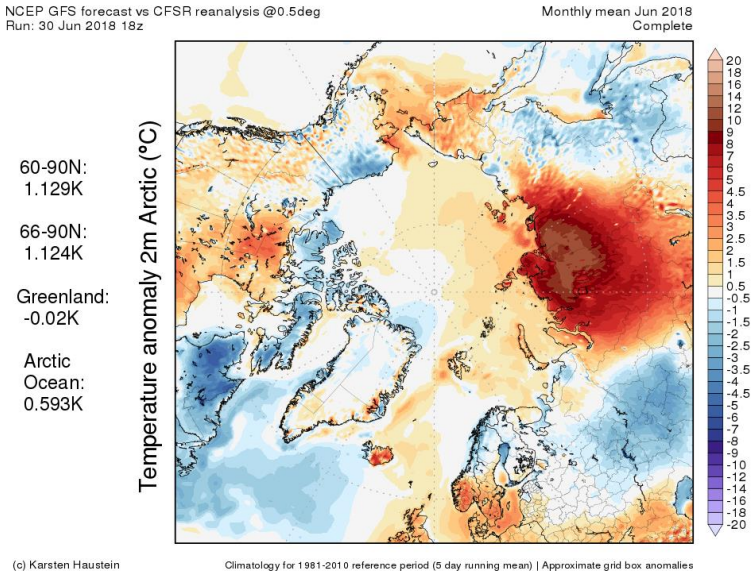


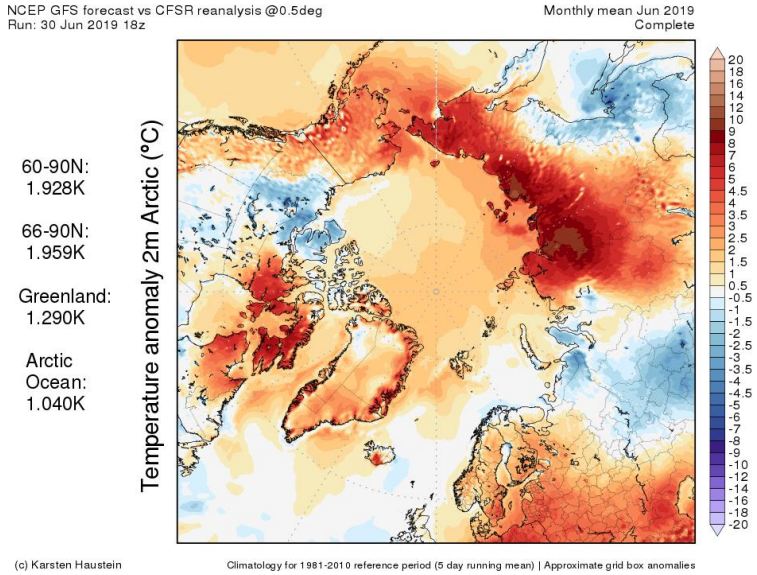
Background

- Climate change proceeds fastest in the Arctic region
  - Arctic summers have become warmer and drier
  - The past 3 summers in the Siberian arctic have been about 2-7ºC warmer than 1981-2010 average

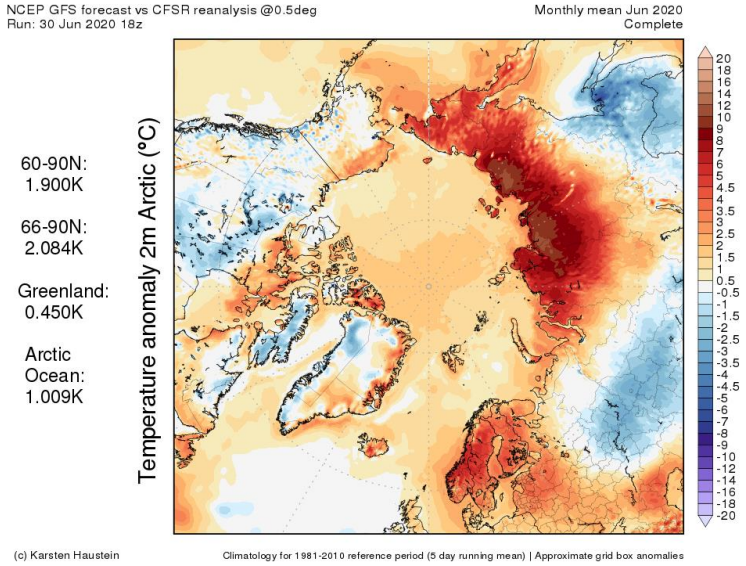
Jun-2018



Jun-2019



Jun-2020

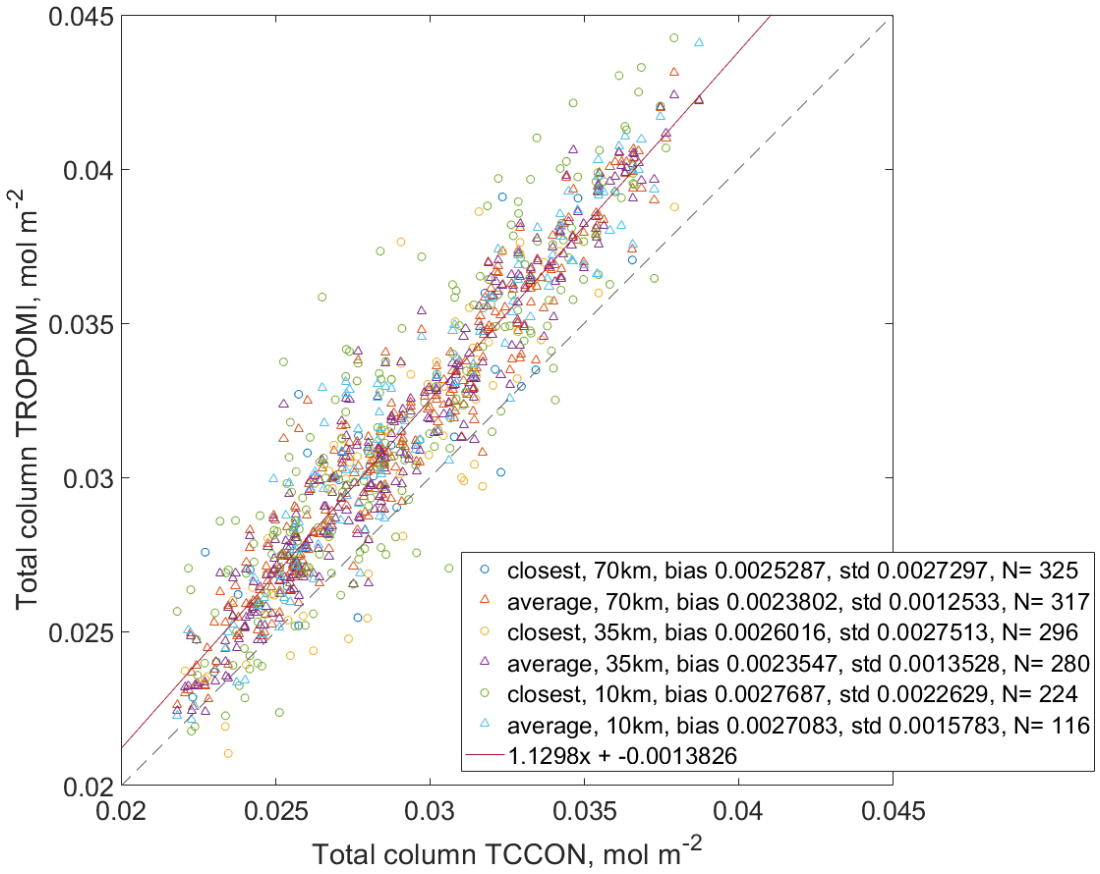


Credit: http://www.karstenhaustein.com/climate.php

Data used

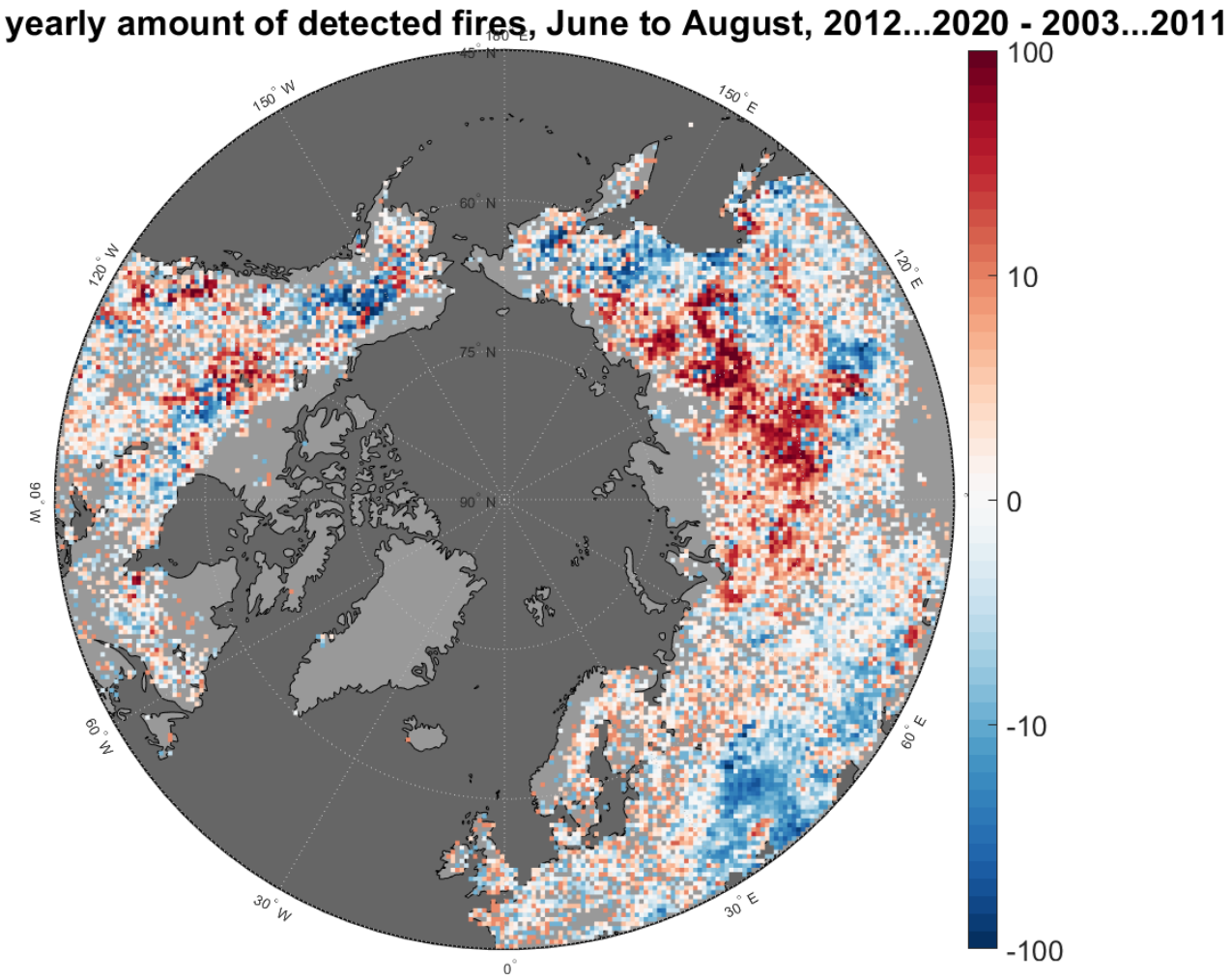
- Carbon monoxide (CO) total column
  - TROPOMI
- Fire Radiative Power
  - MODIS Collection 6 (NASA DAAC)

Validation of TROPOMI CO



- Against Sodankylä TCCON instrument TROPOMI shows overestimation of about 10% with <10% standard deviation in single measurement comparison
- Spatial averaging brings standard deviation to approximately 5 %
- In this study we have used a 50x50 km grid

Spatial evolution of fires in the Arctic using MODIS FRP-data



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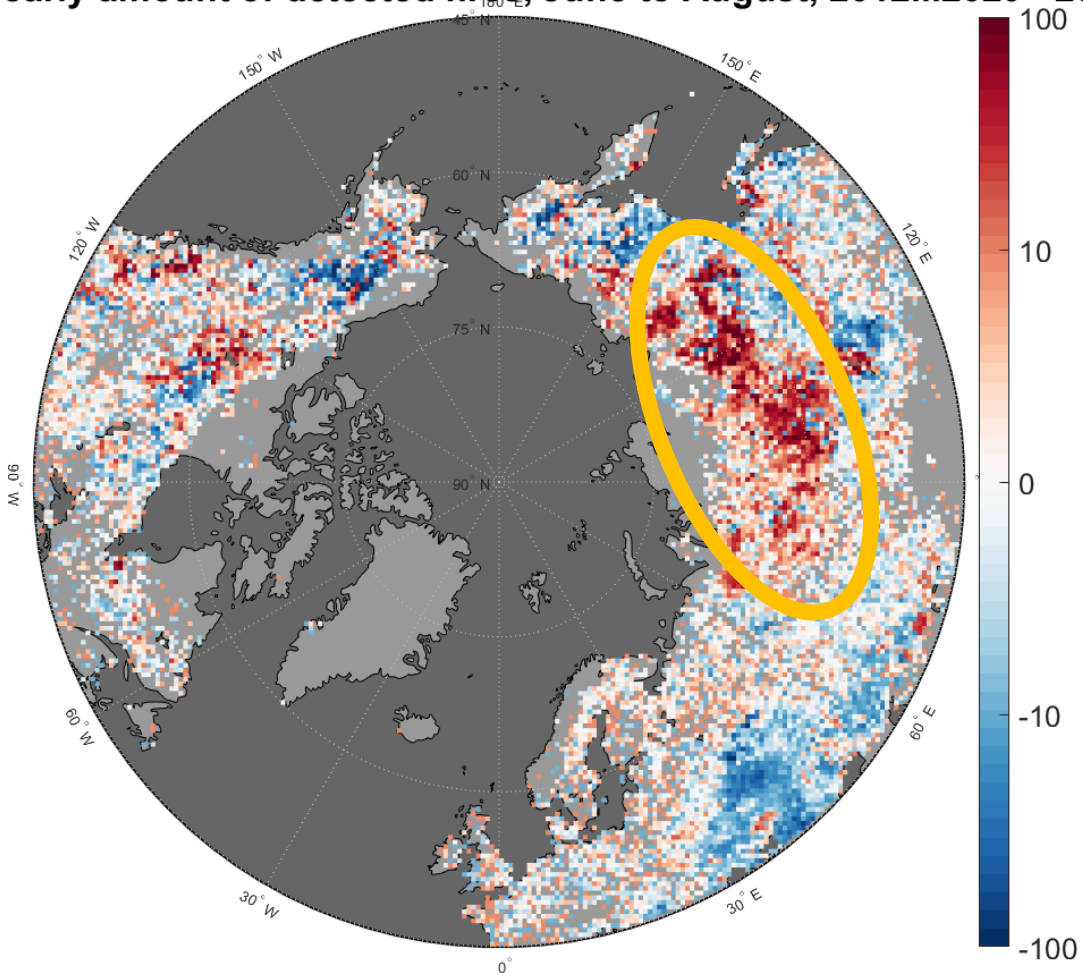
Spatial evolution of fires in the Arctic using MODIS FRP-data

Difference in yearly amount of detected fires, June to August, 2012...2020 - 2003...2011



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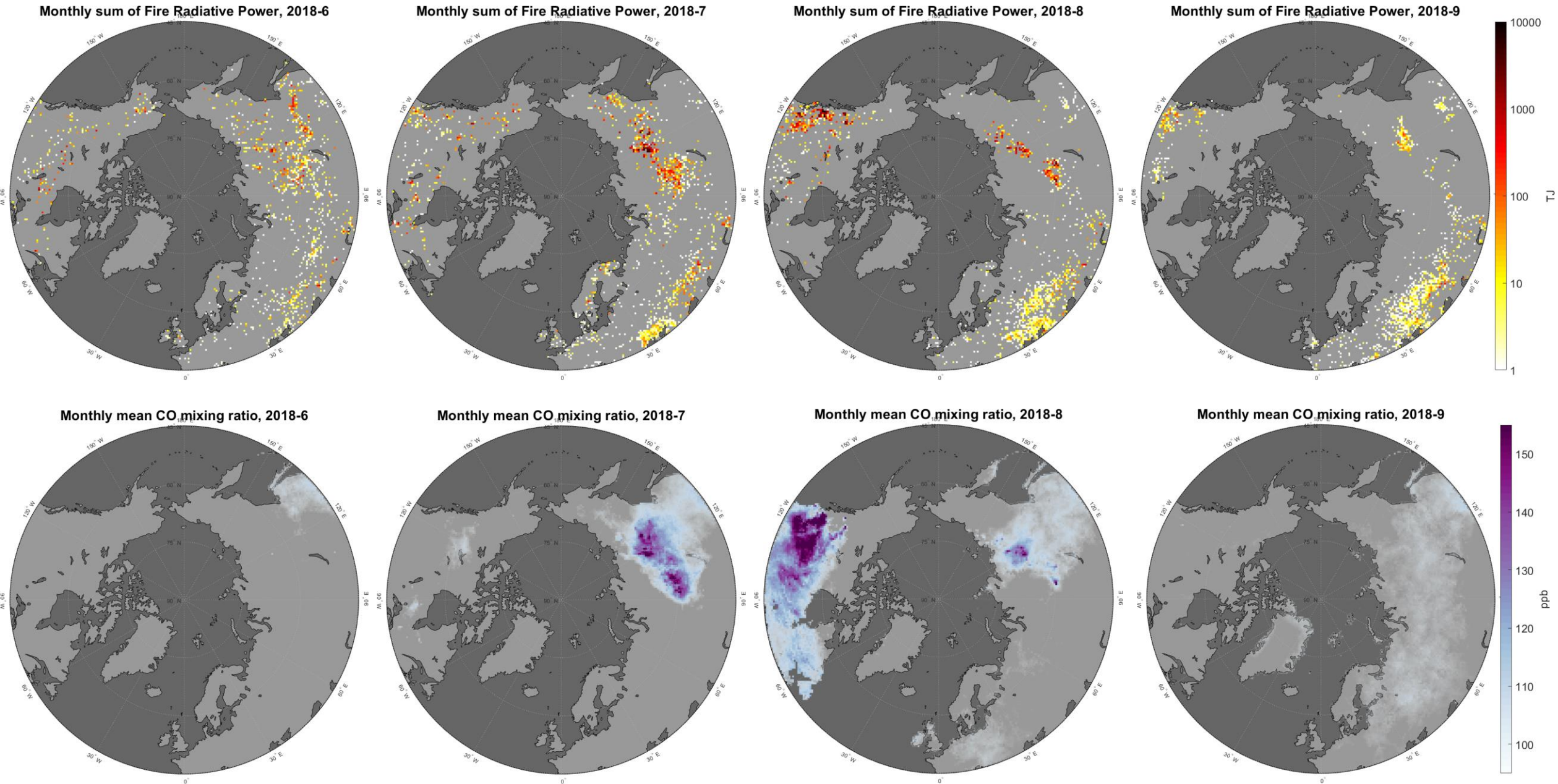
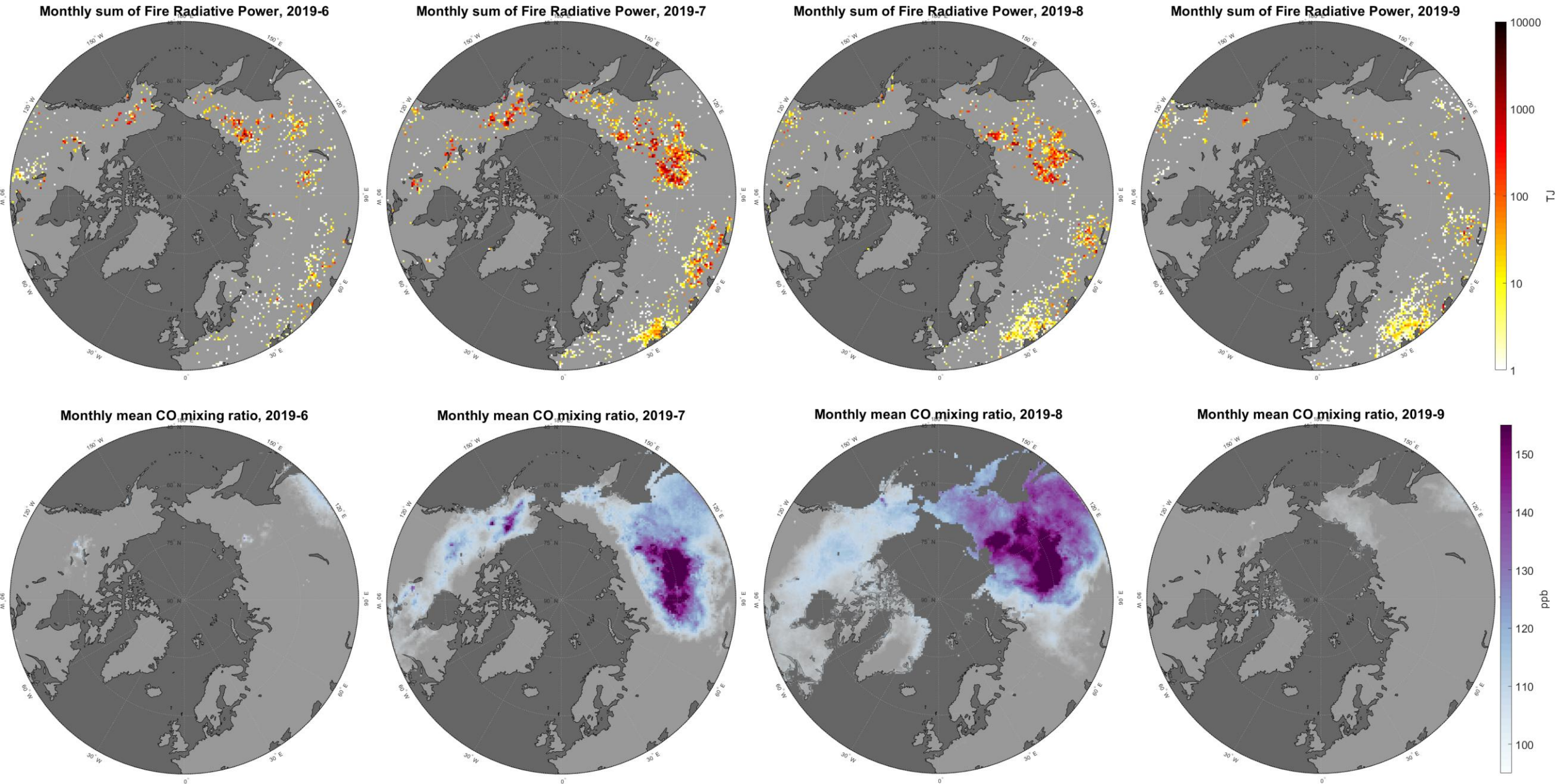
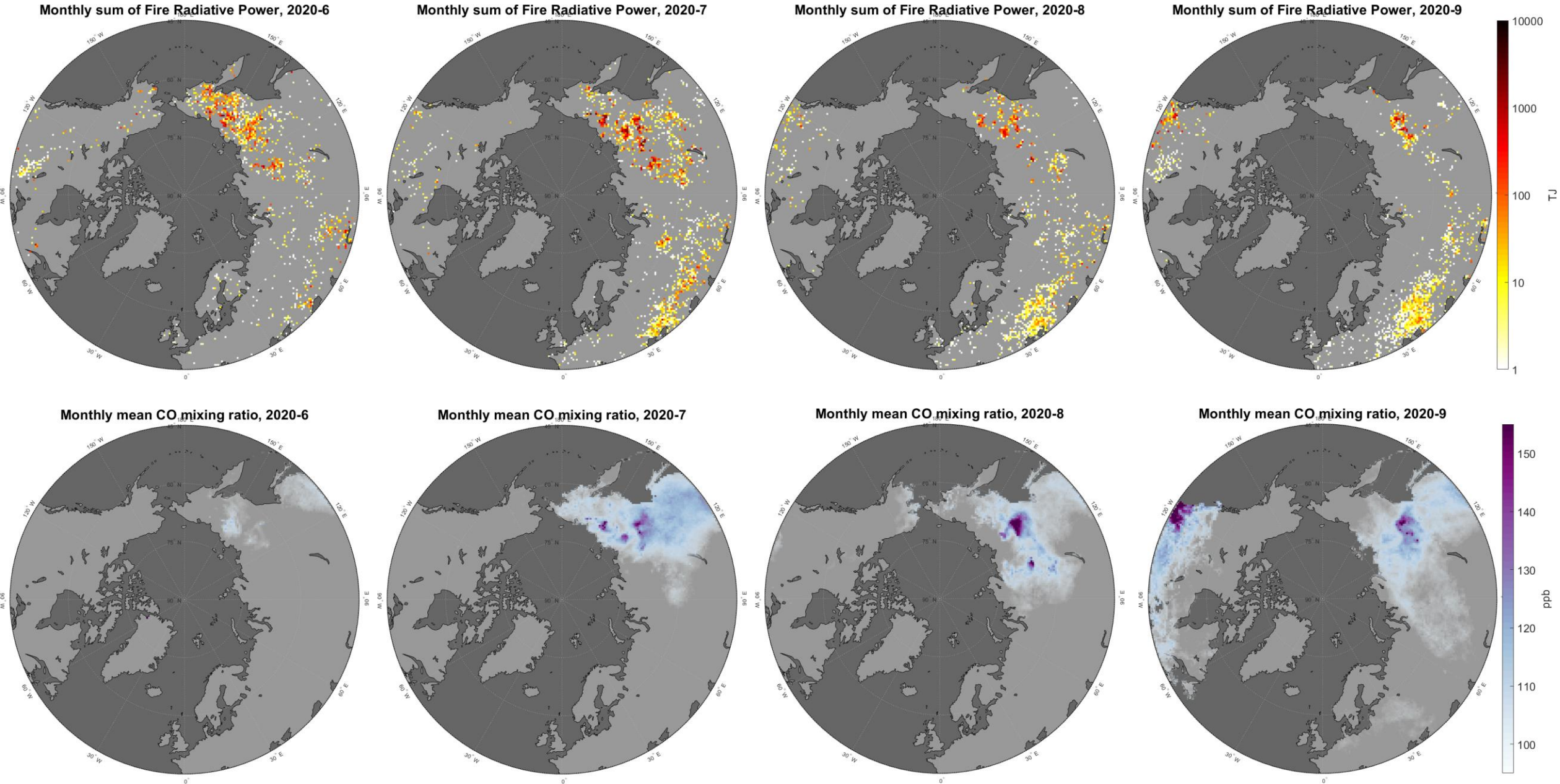
Monthly means summer 2018



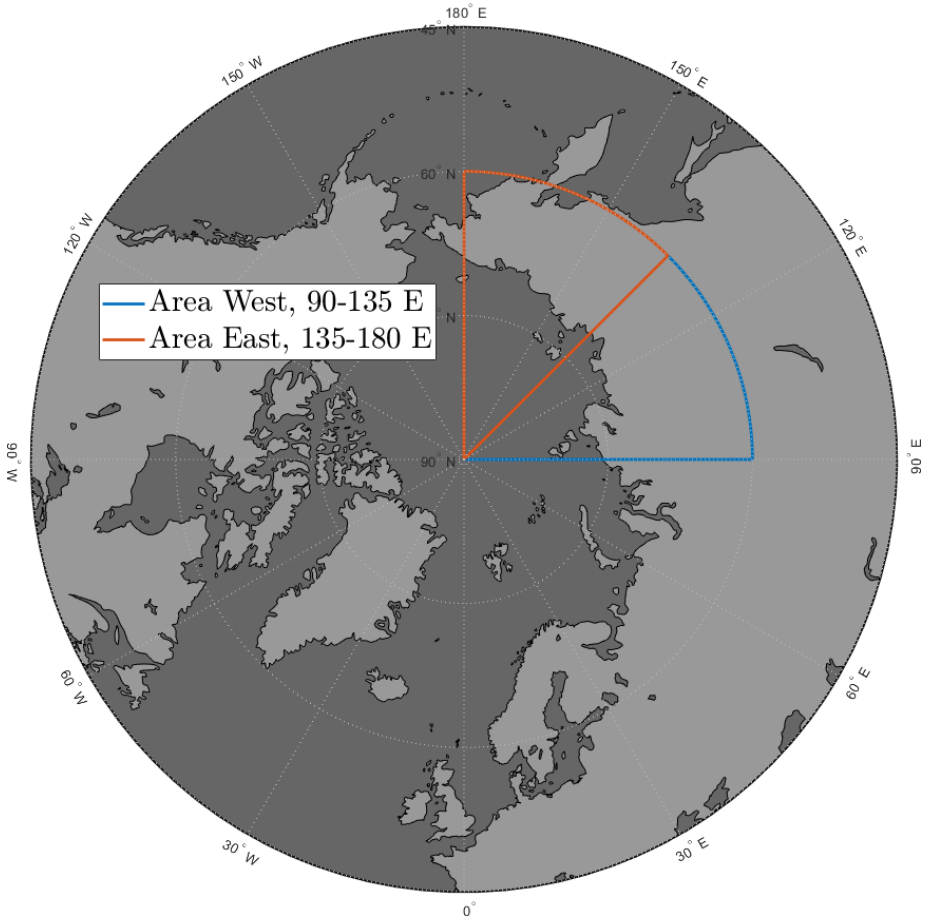
Monthly means summer 2019



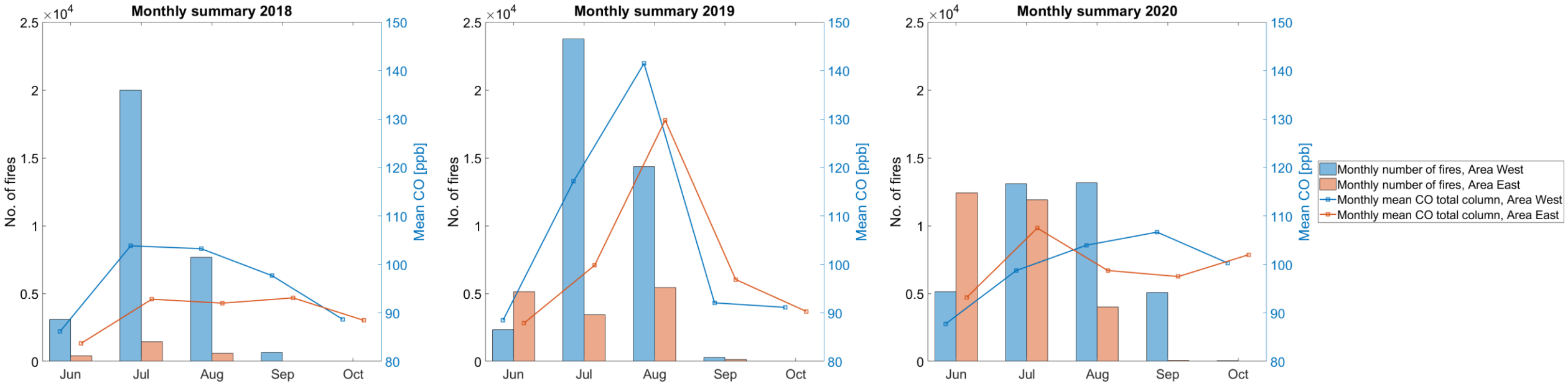
Monthly means summer 2020



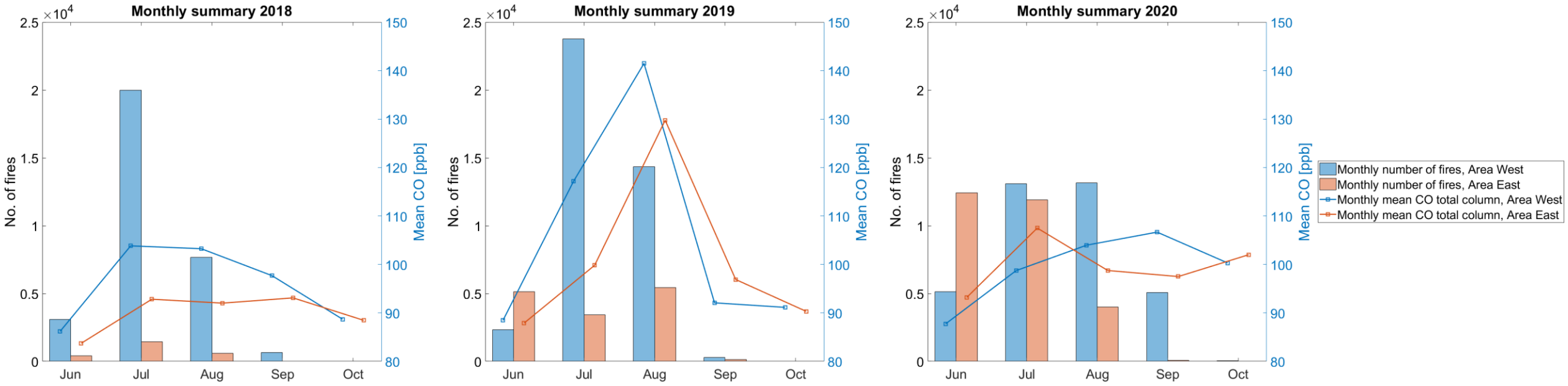
Area of interest, Arctic Siberia



Monthly summary of selected areas

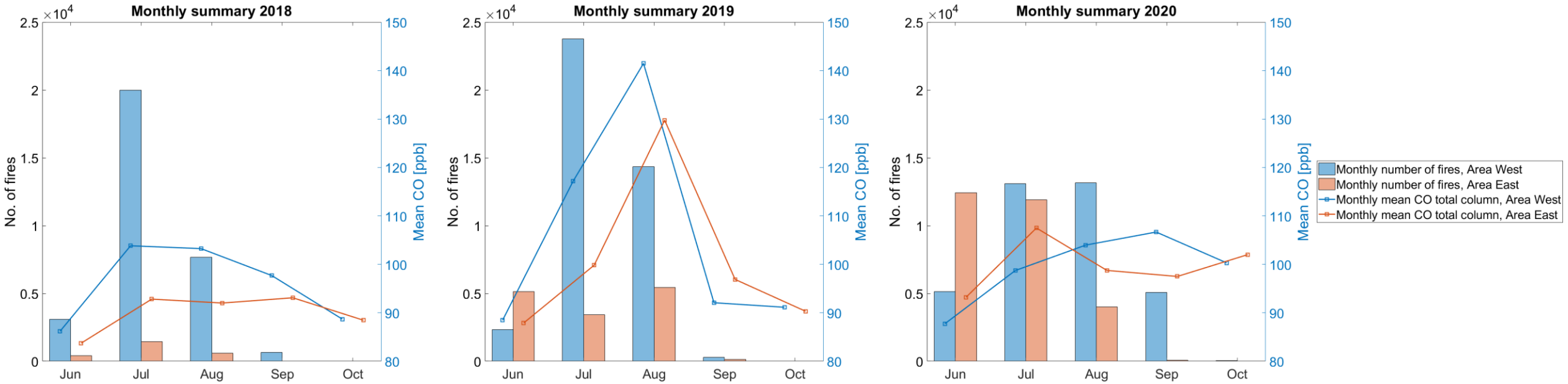


Monthly summary of selected areas



A lot of CO transported
from south of 60° N

Monthly summary of selected areas



Exeptional amount of fires in the Eastern area.

Late fires in September seem to rise also the October CO-levels.

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Summary

- The number of wild fires has risen in the Arctic Siberia
- Fires could affect atmospheric carbon balance in several ways
  - Direct carbon dioxide and carbon monoxide release
  - Methane release from thawing wetlands; enhancement because of the heat of the fires and lower albedo of burnt areas causing more radiation absorption by land
  - Shrinking of atmopheric sink because of large CO-emissions
- Satellites provide valuable information on large scale processes; in this case tracing the CO helps us identify wild fire emissions and their transport

Aknowledgments

- The work is related to PEEX- the Pan Eurasian Experiment
  - Multidisciplinary climate change, air quality, environment and research infrastructure, focused on Northern Eurasian, particularly Arctic and boreal regions.

Pan-Eurasian Experiment
PEEX

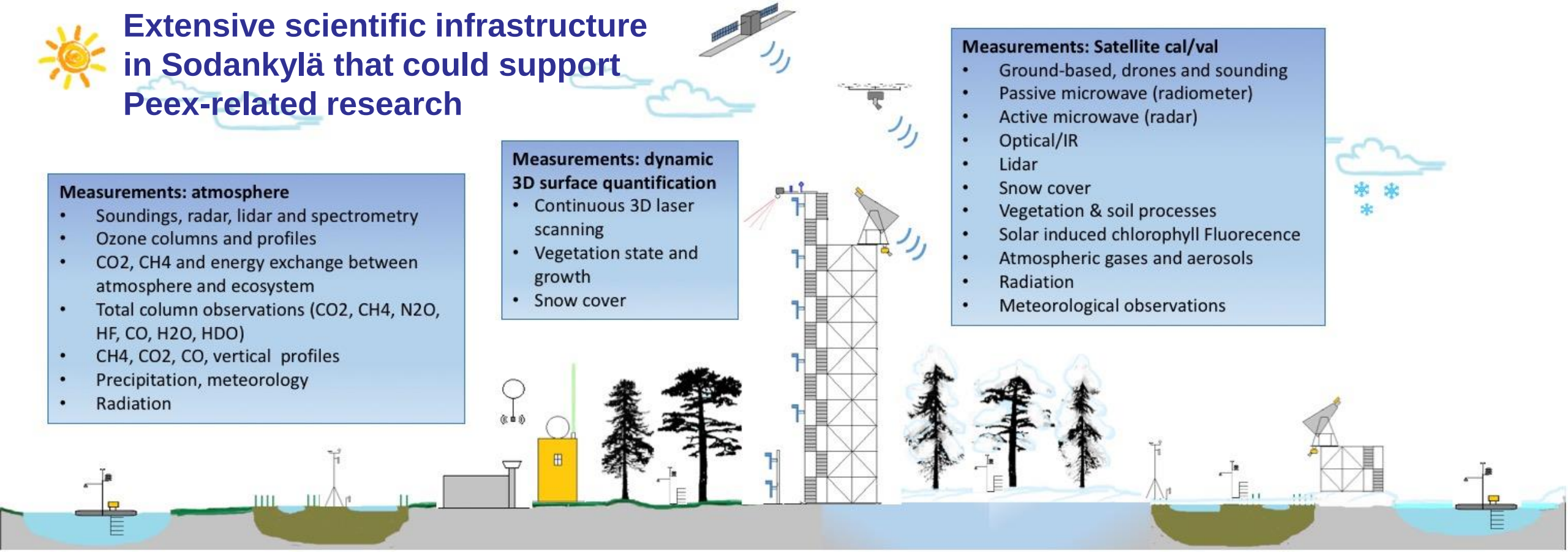
@PEEX_News

Extensive scientific infrastructure in Sodankylä that could support Peex-related research

Measurements: atmosphere
- Soundings, radar, lidar and spectrometry
- Ozone columns and profiles
- CO2, CH4 and energy exchange between atmosphere and ecosystem
- Total column observations (CO2, CH4, N2O, HF, CO, H2O, HDO)
- CH4, CO2, CO, vertical profiles
- Precipitation, meteorology
- Radiation

Measurements: dynamic 3D surface quantification
- Continuous 3D laser scanning
- Vegetation state and growth
- Snow cover

Measurements: Satellite cal/val
- Ground-based, drones and sounding
- Passive microwave (radiometer)
- Active microwave (radar)
- Optical/IR
- Lidar
- Snow cover
- Vegetation & soil processes
- Solar induced chlorophyll Fluorecence
- Atmospheric gases and aerosols
- Radiation
- Meteorological observations



Ecosystem processes (summer)

Water bodies (lake/river)
- CO_2 / CH_4 exchange
- Water level
- Surface temperature
- Sensible and latent heat exchange

Wetland
- CO_2 /CH_4 exchange
- Long-term greening
- Plant phenology
- Water level
- Sensible and latent heat exchange

Forest
- CO_2 exchange
- Long-term greening
- Plant phenology
- Soil humidity
- Sensible and latent heat exchange

Ecosystem processes (winter)

Forest
- Snow - soil – forest interactions
- Snow Water Equivalent
- Soil freezing

Wetland
- Snow – soil - vegetation interactions
- Snow Water Equivalent
- Soil freezing

Water bodies (lake/river)
- Snow - ice interactions
- Freezing